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Phytoplankton in a tropical estuary, Northeast Brazil: composition and life forms

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Abstract: We aimed verify the composition of the phytoplankton community and this life forms that occur in the Capibaribe River estuary, Pernambuco, Brazil. This is a highly impacted ecosystem by anthropic activities. We collected samples of the phytoplankton community at three stations, during three months of each season: dry, from October to December 2010; rainy, from May to July 2011. We collected samples during the low and high tide, at the spring tide. We classified the species based on life forms. We identified 127 taxa, and the majority of species were freshwater planktonic form (FP; 30%), followed by marine oceanic planktonic (MOP; 25%), marine neritic tichoplanktonic (MNT; 22%) and planktonic (MNP; 19%,), and tichoplanktonic estuarine (TE; 3%) and freshwater (TF; 1%). The majority of species identified were diatoms, since it assumes the most variability of life forms, therefore enabling its presence in the different portions at the estuary.

Key words: diatoms; freshwater; marine; plankton; tichoplankton

INTRODUCTION

Estuaries are high dynamic ecosystems affected by marine and limnetic conditions, such as changes in the river flow and marine tides, enabling different characteristic zones along the estuary. Thereby, it is observed great variations of the environmental parameters (Miranda et al. 2002). As a result, the phytoplankton community rapidly responds to these environmental changes (Cloern and Jassby 2010). Phytoplankton are one of the main primary producers in aquatic ecosystems, as well as is considered excellent bioindicators of environmental quality (Reynolds 2006).

The different life forms in the phytoplankton species are dependent, in general, on their response to the heterogeneity of habitats, besides the tolerance to oscillations in the environmental, which can resuspend or deposit cells on the bottom. The knowledge of composition and life forms of the biotic communities is a necessary tool to understand the mechanism and the ecological importance of aquatic ecosystems (Eskinazi-Leça et al. 2004; Cloern and Jassby 2010).

In this context, our study aimed to analyze the composition of the phytoplankton community and the main life forms of species occurring in the Capibaribe River estuary (Pernambuco), which is an important aquatic body in Northeast Brazil.

MATERIALS AND METHODS

Study Area

The Capibaribe River estuary is located in the downtown of the Recife City (Pernambuco state, Northeast Brazil; Figure 1). Because it is located in an area of high degree of urbanization, waters are eutrophized and strongly affected by anthropic activities, mainly due to discharge of domestic and industrial effluents. As consequence, occur high concentrations of ammonia, phosphorus, heavy metals, and thermotolerant coliforms, and turning the levels of dissolved oxygen undetectable (SRH 2010).

Data sampling and analysis

We collected samples for phytoplankton analysis at three sites along the estuary: upstream (S1), downstream (S3), and one intermediate site (S2) along the river. We conducted sampling during three months of each climatic seasons, in the dry (October to December 2010) and rainy (May to July 2011) season, and during high and low tide in the same day, in spring tide.

We collected phytoplankton from the Capibaribe River estuary through superficial horizontal hauls (plankton net of 64 μm mesh size), for 3 minutes. We fixed samples (n = 36) in neutral formaldehyde (Newell and Newell 1963), for subsequent identification and counting by optic microscopy.

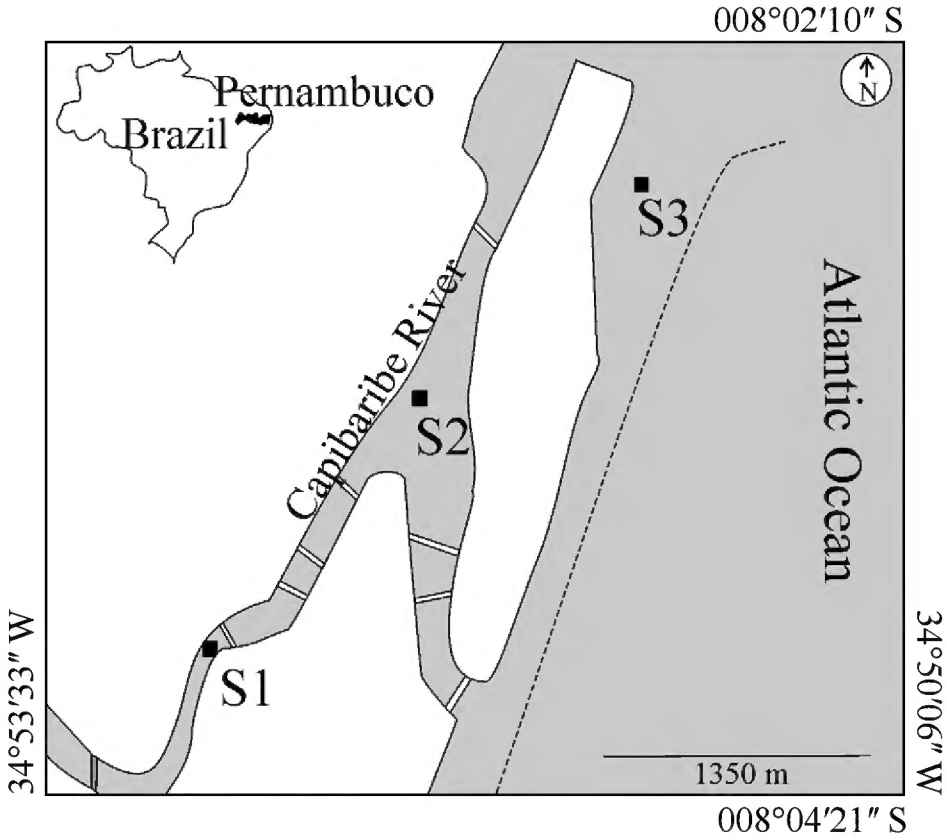

Figure 1. Capibaribe River estuary (Pernambuco state, Brazil), where is located the sampling sites (S1, S2, and S3).

We identified the species based on specific references, as Peragallo and Peragallo (1897-1908), Husted (1961–1966), Cupp (1943), Silva-Cunha and Eskinazi-Leça (1990), Tomas (1993), Sournia (1986), Balech (1988), Licea et al. (1995), Desikachary (1959), Mizuno (1968). When necessary, we observed the chloroplasts using a contrast phase system, and to better identification of the diatom frustule ornamentations we referenced Carr et al. (1986). We used the taxonomic classification system of Guiry and Guiry (2012).

We classified the life forms to only ones the organisms identified until species level. For diatoms, this classification was based on Torgan and Biancamano (1991), Moreira Filho et al. (1990; 1994/95; 1999), and Silva-Cunha and Eskinazi-Leça (1990). For the remaining groups we used the online database from Guiry and Guiry (2012) and Eskinazi-Leça et al. (2013). We considered the following classes: marine oceanic planktonic (MOP), marine neritic planktonic (MNP), marine neritic tichoplanktonic (MNT), tichoplanktonic estuarine (TE), tichoplanktonic freshwater (TF), and freshwater planktonic (FP).

RESULTS

As result, we registered 128 taxa, overwhelming dominated by phylum Ochrophyta (diatoms), which formed 54% of the total, followed by the phyla Cyanobacteria (cyanobacteria, 18%), Chlorophyta (chlorophytes, 13%), Myzozoa (dinoflagellate, 7%), Euglenozoa (euglenophyte, 5%) and Charophyta (charophyte, 3%).

The majority of species identified showed the life forms compatible with FP, corresponding to 30% of the total and consisting mainly of species of chlorophytes and cyanobacteria. Species of MOP represented 25% of the total, followed by MNT and MNP, with 22% and 19%, respectively. Ultimately, species of TE and TF were represented with 3% and 1% of the total, respectively (Table 1). All dinoflagellates identified in the Capibaribe River estuary marine and planktonic life forms, and also other 26 species of diatoms (Table 1). Only *Fragilaria capucina* Desmazières were part of the FT category (Table 1). Two species of diatoms were part of the TE, *Terpsinoë musica* Ehrenberg and *Gyrosigma balticum* (E.) Rabenhorst.

Table 1. Taxa identified in the Capibaribe River estuary and this life form. Codes: (MNT) Marine Neritic Tichoplanktonic; (MNP) Marine Neritic Planktonic; (MOP) Marine Oceanic Planktonic; (FT) Freshwater Tichoplanktonic; (FP) Freshwater Planktonic; (TE) Tichoplanktonic Estuarine.

Taxa	Life form
PHYLUM CYANOBACTERIA	
Class Cyanophyceae	
Order Nostocales	
Anabaena sp.	
Aphanizomenon sp.	
Cylindrospermopsis raciborskii (W.) Seenayya & S. Raju	FP
Nostocales undertemined	
Richelia intracellularis J. Schmidt	MOP
Order Chroococcales	
Chroococcales undertemined	
Chroococcus dispersus (K.) Lemmermann	FP
Microcystis aeruginosa (K.) Kützing	FP
Order Synechococcales	
Coelomoron sp.	
Merismopedia punctata Meyen	FP
Order Pseudanabaenales	
Geitlerinema unigranulatum (R. N. S.) Komárek & Azevedo	FP
Geitlerinema sp.	
Pseudanabaena sp.	
Spirulina subsalsa Oersted	FP
Spirulina sp.	

Taxa	Life form
Order Oscillatoriales	
Lyngbya sp.	
Oscillatoria princeps Vaucher ex Gomont	FP
Oscillatoria sp1	
Oscillatoria sp2	
Phormidium sp1	
Phormidium sp2	
Phormidium sp3	
Planktothrix agardhii (G.) Anagnostidis & Komárek	F
Planktothrix isothrix (S.) Komárek & Komárková	F
PHYLUM EUGLENOZOA	
Class Euglenophyceae	
Order Euglenophyceae	
Colacium sp.	
Order Eutreptiales	
Eutreptiella sp.	
Order Euglenales	
Euglena acus (O. F. M.) Ehrenberg	FP
Phacus sp.	
Phacus acuminata Drezepolskiego	FP
Trachelomonas sp.	

Continued

Table 1. *Continued.*

Taxa	Life form
PHYLUM MYZOZOA	
Class Dinophyceae	
Order Dinophysiales	
Dinophysis caudata Saville-Kent	MNP
Order Gonyaulacales	
Neoceratium extensum (G.) Gomez, Moreira & Garcia	MNP
Neoceratium furca (E.) Gomez, Moreira & Garcia	MNP
Neoceratium fusus (E.) Gomez, Moreira & Garcia	MOP
Neoceratium macroceros (E.) Gomez, Moreira & Garcia	MOP
Neoceratium trichoceros (E.) Gomez, Moreira & Garcia	MOP
Neoceratium tripos (M.) Gomez, Moreira & Garcia	MOP
Order Peridiniales	
Protoperidinium sp1	
Protoperidinium sp2	
PHYLUM OCHROPHYTA	
Class Coscinodiscophyceae	
Order Aulacoseirales	
Aulacoseira granulata (E.) Simonsen	FP
Order Coscinodiscales	
Actinoptychus splendens (S.) Ralfs ex Pritchard	MNT
Coscinodiscus centralis Ehrenberg	MOP
Coscinodiscus kutzing Grunow	MOP
Coscinodiscus nitidus W.Gregory	MNP
Coscinodiscus oculus-iridis (E.) Ehrenberg	MNP
Coscinodiscus sp1	
Coscinodiscus sp2	
Coscinosdiscus sp3	
Order Chaetocerotales	
Bacteriastrum delicatulum Cleve	MOP
Chaetoceros atlanticus Cleve	MOP
Chaetoceros brevis F.Schütt	MNP
Chaetoceros compressus Lauder	MOP
Chaetoceros curvisetus Cleve	MNT
Chaetoceros lorenzianus Grunow	MNP
Chaetoceros peruvianus Brightwell	MOP
Chaetoceros sp1	
Chaetoceros sp2	
Order Hemiaulales	
Bellerochea malleus (B.) Van Heurck	MNP
Order Triceratiales	
Odontella aurita (L.) Agardh	MNT
Cerataulus turgidus (E.) Ehrenberg	MNT
Dimerogramma sp.	
Triceratium pentacrinus (E.) Wallich	MNT
Triceratium broeckii G. Leuduger-Fortmorel	MNT
Order Biddulphiales	
Biddulphia biddulphiana (S.) Boyer	MNT
Terpsinoë musica Ehrenberg	TE
Class Fragilariophyceae	
Order Fragilariales	
Asterionellopsis glacialis (C.) Round	MNP
Fragilaria capucina Desmazières	FT
Fragilaria sp.	
Synedra sp.	
Order Thalassiosirales	
Cyclotella glomerata Bachmann	FP
Cyclotella sp.	
Lauderia sp.	
Skeletonema costatum (G.) Cleve	MNP
Thalassiosira eccentrica (E.) Cleve	MNT
Thalassiosira sp.	
Thalassiosirales undertemined	
Order Lithodesmiales	
Ditylum sp.	
Helicotheca tamesis (S.) Ricard	MNP
Order Rhizosoleniales	
Guinardia flaccida (C.) Peragallo	MOP
Guinardia striata (S.) Hasle	MOP
Proboscia alata (B.) Sundström	MOP
Rhizosolenia setigera Brightwell	MOP
Rhizosolenia styliformis T.Brightwell	MOP
Order Leptocylindrales	
Leptocylindrus danicus Cleve	MNP
Order Paraliales	
Paralia sulcata (E.) Cleve	MNT
Class Bacillariophyceae	
Order Bacillariales	
Bacillaria paxillifera (O. F. M.) Marsson	MOP
Cylindrotheca closterium (E.) Reimann & Lewin	MNT
Nitzschia insignis Gregory	MNT
Nitzschia lorenziana Grunow	MNT
Nitzschia sigma (K.) W.Smith	MNT
Nitzschia sp.	
Pseudo-nitzschia pungens (Grunow ex Cleve) Hasle	MNP
Order Surirellales	
Campylodiscus clypeus (E.) Ehrenberg ex Kützing	MNT
Entomoneis alata (E.) Ehrenberg	MOP
Surirella febigerii Lewis	MNT
Order Naviculales	
Gyrosigma balticum (E.) Rabenhorst	TE
Navicula sp.	
Pinnularia sp.	
Pleurosigma sp1	
Pleurosigma sp2	
Naviculales undertemined	
Class Fragilariophyceae	
Order Licmophorales	
Licmophora abbreviata Agardh	MNT
Licmophora sp.	
Order Thalassionematales	
Thalassionema frauenfeldii (G.) Hallegraeff	MOP
Thalassionema sp.	
Order Melosirales	
Melchersiella hexagonalis Kützing	MNP
Order Rhabdonematales	
Rhabdonema punctatum (Harvey & Barley) Stodder	MNT
Order Striatellales	
Grammatophora marina (L.) Kützing	MOP
PHYLUM CHLOROPHYTA	
Class Chlorellaceae	
Chlorellaceae undertemined	
Class Trebouxiophyceae	
Order Chlorellales	
Actinastrum hantzschii Lagerheim	FP
Micractinium pusillum Fresenius	FP
Oocystis sp.	
Order Trebouxiophyceae	
Crucigenia tetrapedia (K.) Kuntze	FP

Continued

Table 1. *Continued.*

Taxa	Life form
Class Ulvophyceae	
Order Cladaphorales	
Cladophora sp.	
Class Chlorophyceae	
Order Sphaeropleales	
Desmodesmus maximus (West & West) Hegewald	FP
Monoraphidium sp.	
Pediastrum boryanum	FP
Pediastrum duplex Meyen	FP
Pediastrum sp.	
Scenedesmus acutus Meyen	FP
Scenedesmus dimorphus (T.) Kützing	FP
Scenedesmus obliquus (T.) Kützing	FP
Scenedesmus quadricauda Chodat	FP
Order Chlamydomonadales	
Pandorina morum (O.F.M.) Bory de Saint-Vincent	FP
PHYLUM CHAROPHYTA	
Class Charophyceae	
Order Charales	
Chara sp.	
Class Conjugatophyceae	
Order Desmidiales	
Closterium sp.	
Staurastrum sp.	
Order Zygnematales	
Spirogyra sp.	

DISCUSSION

In tropical estuary ecosystems diatoms are the main components of the planktonic flora (Fujita and Odebrecht 2007; Masuda et al. 2011; Borges et al. 2012). Studies with phytoplankton species demonstrated that the predominance of diatoms in estuarine ecosystems is not only due to its high rate of division, but also to its euryhaline ability (Ribeiro et al. 2003).

More recent approaches focusing the phytoplankton community in ecosystems nearby of the Capibaribe River have shown that diatoms are the main organisms of the community. It is explained by the higher levels of silicate in these waters and thus, its benefits the diatom population (Santiago et al. 2010; Borges et al. 2012). In addition, our results suggest that the greater occurrence of diatoms in estuaries, comparing with other groups, is due to the different life forms that this population can assume (Table 1).

Many species that are present in estuaries are originally from the freshwaters, such as chlorophyceans and cyanobacteria species. These species are transported downstream by the river's flow (Masuda et al. 2011). The occurrence of some freshwater cyanobacteria species in our study show that these species are present in some freshwater ecosystems in Northeast Brazil, mostly in rivers and reservoirs that are components of the watershed of the Capibaribe River (Dantas et al. 2012).

On the other hand, dinoflagellates identified during our study were essentially marine and planktonic. These organisms are present in the estuarine environment due to the tide regime, which is responsible for their transport into the estuary (Trigueros and Orive 2000). *T. musica* and *G. balticum* are tycoplanktonic estuarine diatoms. Both species are present in other tropical estuaries in Brazil (Fujita and Odebrecht 2007; Leão et al. 2008; Santiago et al. 2010; Masuda et al. 2011), while *F. capucina* is the only tycoplanktonic freshwater form in the present study, commonly reported in other benthonic substrates (Roberts et al. 2004; Antoniades et al. 2005). The three diatoms mentioned are in water column due to the high dynamism of the estuarine ecosystem, which induces mixture and resuspension of organisms from the bottom (Fujita and Odebrecht 2007).

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